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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

022701-974

U.S. APPLICATION NO. (if known, see 37 C.F.R. 1.5)

UNASSIGNED **10/019694**

INTERNATIONAL APPLICATION NO.
PCT/FR00/01912

INTERNATIONAL FILING DATE
4 JULY 2000

PRIORITY DATE CLAIMED
5 JULY 1999

**TITLE OF INVENTION
METHOD FOR DEHYDROGENOFUORINATION OF AN AROMATIC CARBAMOYL FLUORIDE**

**APPLICANT(S) FOR DO/EO/US
Gilbert GUIDOT et al.**

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:

Verification of Translation of Application into English; Form PCT/IB/306 (2 pgs.); Form PCT/IB/332; Form PCT/IB/308; Form PCT/PEA/416 (and translation thereof); Form PCT/PEA/409 (and translation thereof); International Search Report and Form PCT/ISA/220.



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U.S. APPLICATION NO. (If filing under 37 CFR 1.53) UNASSIGNED 10/019694		INTERNATIONAL APPLICATION NO. PCT/FR00/01912		ATTORNEY'S DOCKET NUMBER 022701-974	
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21. <input checked="" type="checkbox"/> The following fees are submitted:				CALCULATIONS		PTO USE ONLY	
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1,040.00 (950) International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$890.00 (970) International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$740.00 (958) International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$710.00 (956) International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 (962)							
ENTER APPROPRIATE BASIC FEE AMOUNT =							
Surcharge of \$130.00 (154) for furnishing the oath or declaration later than 20 <input type="checkbox"/> 30 <input type="checkbox"/> months from the earliest claimed priority date (37 CFR 1.492(e)).							
Claims	Number Filed	Number Extra	Rate				
Total Claims	15 -20 =	0	X\$18.00 (966)	\$	0.00		
Independent Claims	1 -3 =	0	X\$84.00 (964)	\$	0.00		
Multiple dependent claim(s) (if applicable)					+ \$280.00 (968)	\$	0.00
TOTAL OF ABOVE CALCULATIONS =				\$	890.00		
Reduction for 1/2 for filing by small entity, if applicable (see below).				+	\$		
SUBTOTAL =				\$	890.00		
Processing fee of \$130.00 (156) for furnishing the English translation later than 20 <input type="checkbox"/> 30 <input type="checkbox"/> months from the earliest claimed priority date (37 CFR 1.492(f)).							
TOTAL NATIONAL FEE =				\$	890.00		
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 (581) per property							
TOTAL FEES ENCLOSED =				\$	890.00		
				Amount to be refunded:		\$	
				charged:		\$	

a. ☐ Small entity status is hereby claimed.

b. ☒ A check in the amount of \$ 890.00 to cover the above fees is enclosed.

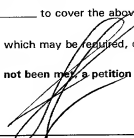
c. ☐ Please charge my Deposit Account No. 02-4800 in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

d. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-4800. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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SIGNATURE

 TERESA STANEK REA
 NAME
 30,427
 REGISTRATION NUMBER
 JANUARY 3, 2002
 DATE

Patent
Attorney's Docket No. 022701-974

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of)
)
Gilbert GUIDOT et al) Group Art Unit: Unassigned
)
Application No.: Unassigned) Examiner: Unassigned
(Corresponds to PCT/PCT/FR00/01912))
)
International Filing Date: July 4, 2000)
)
For: METHOD FOR)
DEHYDROGENOFLUORINATION OF)
AN AROMATIC CARBAMOYL)
FLUORIDE)

PRELIMINARY AMENDMENT

BOX PCT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-captioned application as follows:

IN THE CLAIMS:

Kindly amend claims 1-15 as follows.

1. (Amended) A dehydrofluorination process to convert an aromatic carbamoyl fluoride to the corresponding isocyanate, comprising subjecting carbamoyl fluoride to a temperature at least equal to 80°C, in a solvent and at a temperature of at least 80°C, wherein said carbamoyl fluoride is in the dissolved or finely dispersed state in the solvent.

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2. (Amended) The process as claimed in claim 1, wherein said reaction temperature is at most equal to 150°C.
3. (Amended) The process as claimed in claim 1, wherein said solvent exhibits a boiling point of at least 100°C.
4. (Amended) The process as claimed in claim 1, wherein the reaction is carried out at a pressure such that, at the reaction temperature, the solvent is boiling.
5. (Amended) The process as claimed in claim 1, wherein the solvent is miscible with hydrofluoric acid which does not react with the carbamoyl fluoride.
6. (Amended) The process as claimed in claim 1, wherein said carbamoyl fluoride is introduced into the solvent with hydrofluoric acid.
7. (Amended) The process as claimed in claim 6, wherein the ratio of the hydrofluoric acid to the carbamoyl fluoride (HF/carbamoyl fluoride) is at least equal to 2.
8. (Amended) The process as claimed in claim 1, wherein the addition of the carbamoyl fluoride takes place gradually to a solvent heel brought to the chosen reaction temperature.

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9. (Amended) The process as claimed in claim 1, wherein the addition is carried out at a rate such that, in the ten final 90% of the reaction duration taking place below 100°C, the molar ratio of hydrofluoric acid to isocyanate (HF acid/aromatic isocyanate) is always less than 0.5.

10. (Amended) The process as claimed in claim 1, wherein the carbamoyl fluoride substrate comprises an aliphatic carbon, that is sp^3 hybridization, carrying at least two fluorines.

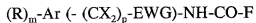
11. (Amended) The process as claimed in claim 10, wherein said aliphatic carbon carrying at least two fluorines is a benzyl carbon and is directly attached to an aromatic ring.

12. (Amended) The process as claimed in claim 11, wherein said aromatic ring is that carrying the nitrogen of the carbamoyl functional group.

13. (Amended) The process as claimed in claim 1, wherein the reaction mixture comprises less than 1%, with respect to the starting carbamoyl fluoride, expressed as moles, of impurities exhibiting a chlorine in the benzyl position.

14. (Amended) The process as claimed in claim 1, wherein the substrate corresponds to the formula:

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where:

- Ar is an aromatic residue;
- the X units, which are alike or different, represent a fluorine or a radical of formula C_nF_{2n+1} with n an integer at most equal to 5;
- p represents an integer at most equal to 2;
- EWG represents a hydrocarbonaceous group or an electron-withdrawing group, the optional functional groups of which are inert under the reaction conditions.

The total carbon number of $-(CX_2)_p-EWG$ is between 1 and 15;

- m is 0 or an integer comprising 1 to 4;
- R represents alike or different radicals comprising halogens or hydrocarbonaceous radicals.

15. (Amended) The process as claimed in claim 1, wherein the solvents are selected from the group consisting of chlorobenzenes, advantageously monochloro-, dichloro- and trichlorobenzenes.

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REMARKS

Entry of the foregoing amendment(s) is respectfully requested.

The claims have been amended to eliminate multiple dependency and to place them in better condition for U.S. patent practice.

Should the Examiner have any questions concerning the subject application, a telephone call to the undersigned would be appreciated.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

By: 

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Date: January 3, 2002

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Application No. Unassigned
Attorney's Docket No. 022701-974
Mark-up of Claims - Page 1

Attachment to Preliminary Amendment dated January 3, 2002

1. (Amended) A dehydrofluorination process [which makes it possible] to convert an aromatic carbamoyl fluoride to the corresponding isocyanate, [characterized in that said] comprising subjecting carbamoyl fluoride [is subjected] to a temperature at least equal to 80°C, [advantageously at least equal to 90°C,] in a solvent and [in that,] at [said] a temperature of at least 80°C, wherein said carbamoyl fluoride is in the dissolved or finely dispersed state in the solvent.

2. (Amended) The process as claimed in claim 1, [characterized in that] wherein said reaction temperature is at most equal to 150°C.

3. (Amended) The process as claimed in [claims 1 and 2] claim 1, [characterized in that] wherein said solvent exhibits a boiling point of at least 100°C[, advantageously 120°C].

4. (Amended) The process as claimed in [claims 1 to 3] claim 1, [characterized in that] wherein the reaction is carried out at a pressure such that, at the reaction temperature, the solvent is boiling.

5. (Amended) The process as claimed in [claims 1 to 4] claim 1, [characterized in that] wherein the solvent is [chosen from those which are] miscible with hydrofluoric

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Attachment to Preliminary Amendment dated January 3, 2002

acid[, advantageously from halogenated aromatic derivatives] which [do] does not react with the carbamoyl fluoride.

6. (Amended) The process as claimed in [claims 1 to 5] claim 1, [characterized in that] wherein said carbamoyl fluoride is introduced into the solvent with hydrofluoric acid[, advantageously in the form of a solution in anhydrous hydrofluoric acid].

7. (Amended) The process as claimed in claim 6, [characterized in that] wherein the ratio of the hydrofluoric acid to the carbamoyl fluoride (HF/carbamoyl fluoride) is at least equal to 2[, advantageously to 3, preferably to 4].

8. (Amended) The process as claimed in [claims 1 to 7] claim 1, [characterized in that] wherein the addition of the carbamoyl fluoride[, advantageously in the form of a solution,] takes place gradually to a solvent heel brought to the chosen reaction temperature.

9. (Amended) The process as claimed in [claims 1 to 8] claim 1, [characterized in that] wherein the addition is carried out at a rate such that, in the ten final 90% of the reaction duration taking place below 100°C, [advantageously below 90°C,] the molar ratio of hydrofluoric acid to isocyanate (HF acid/aromatic isocyanate) is always less than 0.5[, advantageously than 0.3, preferably than 0.1].

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Attachment to Preliminary Amendment dated January 3, 2002

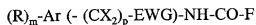
10. (Amended) The process as claimed in [claims 1 to 9] claim 1, [characterized in that] wherein the carbamoyl fluoride substrate comprises an aliphatic carbon, that is [to say of] sp^3 hybridization, carrying at least two fluorines.

11. (Amended) The process as claimed in claim 10, [characterized in that] wherein said aliphatic carbon carrying at least two fluorines is a benzyl carbon[, that is to say that it] and is directly attached to an aromatic ring.

12. (Amended) The process as claimed in claim 11, [characterized in that] wherein said aromatic ring is that carrying the nitrogen of the carbamoyl functional group.

13. (Amended) The process as claimed in [claims 1 to 12] claim 1, [characterized in that] wherein the reaction mixture comprises less than 1%, with respect to the starting carbamoyl fluoride, expressed as moles, of impurities exhibiting a chlorine in the benzyl position.

14. (Amended) The process as claimed in [claims 1 to 13] claim 1, [characterized in that [lacuna]] wherein the substrate corresponds to the formula:



where:

- Ar is an aromatic residue;

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Attachment to Preliminary Amendment dated January 3, 2002

- the X units, which are alike or different, represent a fluorine or a radical of formula C_nF_{2n+1} with n an integer at most equal to 5[, preferably to 2];
- p represents an integer at most equal to 2;
- EWG represents a hydrocarbonaceous group or an electron-withdrawing group, the optional functional groups of which are inert under the reaction conditions[, advantageously fluorine or a perfluorinated residue of formula C_nF_{2n+1} with an integer at most equal to 8, advantageously to 5].

The total carbon number of $-(CX_2)_p$ -EWG is [advantageously] between 1 and 15[, preferably between 1 and 10.];

- m is 0 or an integer [chosen within the closed range (that is to say,) comprising [the limits)] 1 to 4;
- R represents alike or different radicals [chosen from] comprising halogens[, advantageously light halogens (that is to say, chlorine and fluorine), and] or hydrocarbonaceous radicals[, preferably alkyl, aryl, alkylchalcogenyl (such as alkyloxy) or arylchalcogenyl (such as aryloxy) radicals].

15. (Amended) The process as claimed in [claims 1 to 14] claim 1, [characterized in that] wherein the solvents are [chosen] selected from the group consisting of chlorobenzenes, advantageously monochloro-, dichloro- and trichlorobenzenes.

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Published:

- With the International Search Report.
- Before expiry of the period provided for amending the claims, will be republished if such amendments are received.

For an explanation of the two-letter codes and the other abbreviations, reference is made to the explanations ("Guidance Notes on Codes and Abbreviations") at the beginning of each regular edition of the PCT Gazette.

As printed

(54) Title: METHOD FOR DEHYDROGENOFUORINATION OF AN AROMATIC CARBAMOYL FLUORIDE

(54) Titre: PROCEDE DE DESHYDROGENOFUORATION D'UN FLUORURE DE CARBAMOYLE AROMATIQUE

(57) Abstract: The invention concerns a method for dehydrogenofluorination for transforming an aromatic carbamoyl fluoride into the corresponding isocyanate. Said method is characterised in that it consists in subjecting said carbamoyl fluoride to a temperature not less than 80 °C, in a solvent and at said temperature, said carbamoyl fluoride is in dissolved state or finely dispersed in the solvent. The invention is applicable to organic synthesis.

(57) A brévé: La présente invention a pour objet un procédé de déshydrogénofluorination permettant de passer d'un fluorure de carbamoyle aromatique à l'isocyanate correspondant. Ce procédé est caractérisé par le fait que l'on soumet ledit fluorure de carbamoyle à une température au moins égale à 80°C, dans un solvant et qu'à ladite température, ledit fluorure de carbamoyle est à l'état dissous ou finement dispersé dans le solvant. Application à la synthèse organique.

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PROCESS FOR THE DEHYDROFLUORINATION OF AN AROMATIC
CARBAMOYL FLUORIDE

A subject matter of the present invention is a process
5 which makes possible the treatment of an aromatic
carbamoyl fluoride to result in the corresponding
isocyanate.

A more particular subject matter of the
present invention is a process of the preceding type
10 which makes it possible to obtain a good degree of
conversion, a good conversion yield, that is to say a
good selectivity, and a good reaction yield.

Carbamoyl fluorides are rather uncommon
compounds which have, however, experienced renewed
15 interest because of the growing role of fluorinated
derivatives in pharmacology and agrochemistry. This is
because one of the most conventional techniques for
synthesizing derivatives exhibiting a perfluorinated
aliphatic carbon consists in blocking possible anilines
20 in the form of an isocyanate, in chlorinating
(generally the alkyl derivative position by means of
radical chlorine, and then treating the chlorinated
derivative obtained with a fluorinated medium,
generally a medium comprising hydrofluoric acid in the
25 liquid phase. During this type of process, the first
reaction which takes place is the addition of hydro-
fluoric acid to the isocyanate functional group to give

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a carbamoyl fluoride.

This carbamoyl fluoride is very difficult to convert into isocyanate. This is a great pity as the isocyanate is a very reactive intermediate which makes possible numerous syntheses and which in particular makes possible ready release of the corresponding aniline.

The first part of the reactions is disclosed in various documents and in particular in the document EP-A 152 310 and the document EP-A 129 214. As regards the conversion of the carbamoyl fluoride to the isocyanate, British patent No. 955 898, published on April 22, 1964, on behalf of Bayer, indicates the possibility of carrying out this reaction, in particular in example 1. However, the technique used results in a low yield (35%), the reaction apparently being very difficult and resulting in particular in heavy products described as resins.

This is why one of the aims of the present invention is to provide a process which makes possible the conversion of carbamoyl fluoride to an isocyanate functional group under operating conditions which are easy to employ and which makes possible good reaction yields and good selectivity.

One of the main difficulties encountered during the study which led to the present invention is the very high reactivity of carbamoyl fluoride with

respect to itself or with respect to rich aromatic rings.

These aims and others which will become apparent subsequently are achieved by means of a dehydrofluorination process which makes it possible to convert an aromatic carbamoyl fluoride to an isocyanate, in which process said carbamoyl fluoride is subjected to a temperature at least equal to 80°C, advantageously at least equal to 90°C, in a solvent and that, at said temperature of at least 80°C, said carbamoyl fluoride is in the dissolved or finely dispersed state in said solvent.

According to the present invention, it has thus been possible to demonstrate that the finely dispersed nature or the dissolved nature of the carbamoyl fluoride at a temperature where it is reactive plays a key role in the production of the isocyanate with a good yield.

The reaction will preferably be carried out at a temperature at most equal to 150°C.

Said solvent exhibits a boiling point (starting boiling point in the case of a mixture) advantageously of at least 100°C, more preferably of at least 120°C.

It is preferable to arrange for the pressure in the reactor to be such that the solvent is boiling (that is to say, in the great majority of cases, at

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reflux). A pressure greater than atmospheric pressure will thus be chosen if the solvent exhibits a boiling point lower than the temperature at which it is desired to operate and a pressure lower than atmospheric pressure will thus be chosen when the solvent has a boiling point higher than the temperature at which it is desired to operate.

According to one of the preferred implementations of the present invention, the solvent, which can moreover be a mixture of solvents, is chosen from those which are miscible with hydrofluoric acid.

This miscibility can be partial or complete but it is preferable for the miscibility to be such that the solvent, or the mixture of solvents, chosen exhibits an ability to dissolve the hydrofluoric acid which is at least equal to 5% by volume, preferably at least equal to 10% by volume. This solubility is of considerable advantage as this miscibility of the solvent with hydrofluoric acid makes it possible to use the latter as third solvent, facilitating the dissolution of the carbamoyl fluoride in the reaction mixture.

Consequently, according to a preferred form of the present invention, hydrofluoric acid is used to facilitate the introduction of the carbamoyl fluoride into the reaction mixture. This introduction can be carried out at low temperature or can be introduced at

high temperature. During the heating or during the introduction, when the carbamoyl fluoride is introduced into a solvent heel, the hydrofluoric acid which helps in the dissolution is removed but, on being removed, it
5 leaves the carbamoyl fluoride in a form which is either highly divided or even dissolved in the solvent used.

According to a preferred embodiment, during the introduction of the carbamoyl fluoride, the ratio of the hydrofluoric acid to the carbamoyl fluoride (HF
10 to carbamoyl fluoride ratio) is at least equal to .2, advantageously to 3, preferably to 4.

According to one of the preferred implementations of the present invention, the addition of carbamoyl fluoride is carried out in the form of a
15 solution of the latter in hydrofluoric acid, the ratios indicated above being observed.

The best results obtained correspond to the addition of a solution of carbamoyl fluoride to a solvent heel which is at the reaction temperature.

20 This solution is advantageously a solution in hydrofluoric acid, as indicated above.

In the case of an addition to a solvent heel, the addition must be carried out so as to control the ratio of the hydrofluoric acid present in the reaction
25 medium, in this specific case including that added, more exactly in equilibrium with the carbamoyl fluoride, to the substrate.

In other words, the ratio of the hydrofluoric acid [the free hydrofluoric acid and that added to an isocyanate functional group (that is to say, in the form of carbamoyl fluoride)] and the isocyanate functional groups, real or masked in the carbamoyl fluoride form, is advantageously at most equal to 5, preferably at most equal to 0.3, more preferably at most equal to 0.1. This condition implies a relatively slow addition of the carbamoyl fluoride.

According to the present invention, it is particularly advantageous to avoid the presence of impurities having a chlorine in the benzyl position as, in the context of this reaction, these impurities appear to be highly reactive and would destroy a number of substrates or compounds deriving therefrom.

By way of indication, it is preferable for the number of molecules carrying chlorine in the benzyl functional group to be at most equal to 0.5 to 5%, advantageously to 2%, preferably to 1%, of the carbamoyl fluorides to be treated.

The substrates which are most suitable for the present invention are carbamoyl fluorides which comprise an aliphatic carbon with sp^3 hybridization carrying at least two fluorines. This aliphatic carbon is generally a benzyl carbon, that is to say that it is attached directly to an aromatic ring. However, it can be attached to the aromatic ring via a chalcogen (in

particular oxygen).

The present invention is particularly suited to the case where said aromatic ring is that carrying the nitrogen of the carbamoyl functional group.

5 Such a substrate can comprise several of these aliphatic carbons carrying at least two fluorines.

Thus, the substrate advantageously corresponds to the formula:

10 $(R)_m - Ar(- (CX_2)_p - EWG) - NH - CO - F$

where:

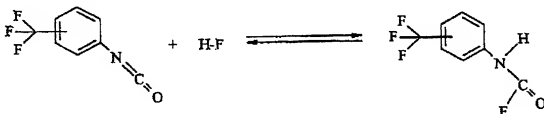
- Ar means an aromatic residue advantageously exhibiting at least one, preferably two, more particularly three, of the following characteristics:
 - 15 - the residue is mononuclear, that is to say comprises only one ring;
 - the residue is advantageously homocyclic;
 - the residue has six ring members;
- the X units, which are alike or different, represent
 - 20 a fluorine or a radical of formula C_nF_{2n+1} with n an integer at most equal to 5, preferably to 2;
 - p represents an integer at most equal to 2;
 - EWG represents a hydrocarbonaceous group or an electron-withdrawing group, the optional functional
 - 25 groups of which are inert under the reaction conditions, advantageously fluorine or a perfluorinated residue of formula C_nF_{2n+1} with an

integer at most equal to 8, advantageously to 5.

The total carbon number of $-(CX_2)_p$ -EWG is advantageously between 1 and 15, preferably between 1 and 10.

- 5 ▫ m is 0 or an integer chosen within the closed range (that is to say, comprising the limits) 1 to 4;
- R is a substituent which is inert under the operating conditions and which is advantageously chosen from halogens, advantageously light halogens (that is to say, chlorine and fluorine), and hydrocarbonaceous radicals, preferably alkyl, aryl, alkylchalcogenyl (such as alkyloxy) or arylchalcogenyl (such as aryloxy) radicals.

10 The substrate compound can in particular have the formula (the optional substituents inert under the reaction conditions are not displayed):



Advantageously, R is an aryl or alkyl hydrocarbonaceous radical, advantageously with at most 10 carbon atoms, preferably with at most 5 carbon atoms, R can also be carboxyl functional groups, nitriles, ketones and fluorocarbonyls.

The preferred substituents are either nothing, that is to say hydrogen, or aryls or alkyls or

alkyloxys.

R or at least one of the R groups can also be a group comprising a carbon carrying at least two fluorines, of formula CX_p -EWG as above.

- 5 The following examples illustrate the invention.

Example 1

Elimination of hydrofluoric acid in a solvent capable of dissolving the carbamoyl fluoride

- 10 The solid carbamoyl fluoride (0.1 mol) is charged to a 180 ml Teflon reactor capable of withstanding hydrofluoric acid which is heated by a regulated oil bath and is magnetically stirred. Tri-chlorobenzene (chlorinated in the 1, 3 and 4 position)
15 is then charged in an amount of 100.4 g.

- This results in a suspension easily to be heated. The medium is gradually heated to 80°C and becomes homogeneous, translucent and orange yellow. Evolution of gas begins in the vicinity of 100°C and
20 becomes significant from 105°C. The temperature is raised to 125°C and heated for 7 hours. After cooling, a mass corresponding to an isolated yield of 80% is recovered.

- The compound is subsequently subjected to
25 distillation and a yield of 73% in solution in tri-chlorobenzene is recovered, some resins remaining in the distillation residue.

Example 2

Different tests were carried out using monochlorobenzene as solvent according to various procedures. The most commonly employed procedure is as follows:

A) Preparation of the carbamoyl fluoride solution

HF is introduced into a reactor at a temperature of -5°C. The trichloromethylphenyl isocyanate which it is desired to convert is then introduced at the desired fluorination temperature, the fluorination lasts 1 h 30, unless indicated otherwise in the subsequent table, and a finishing operation is carried out for 4 h at the temperature indicated in the table. It will be observed that, when everything is otherwise the same apart from the finishing temperature, the yields are better when the finishing temperature is brought to a relatively high temperature, that is to say approximately 20-25°C. This phenomenon shows the extremely harmful effect of small amounts of derivatives remaining chlorinated just the once in the benzyl position.

B) Reversion to isocyanate

The carbamoyl fluoride solution, which may or may not have been subjected to removal of HF beforehand, is introduced into a reactor under the conditions specified in the table below. The heating, pressure and temperature conditions are also specified in the

table.

The results are collated in the following table:

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No. of the test	HF 07	HF 08	HF 09	HF 10	HF 11	HF 12	HF 13	HF 14	HF 15	HF 16
Fluorination temperature	-5°C	-5°C	-5°C	2°C	2°C	2°C	2°C	-5°C	-5°C	-5°C
Finishing temperature	2°C	2°C	20°C	20°C	20°C	20°C	20°C	20°C	25°C	25°C
HF removal beforehand	No	Yes	No	Yes	No	No	No	No	Yes	Yes
HF released during the distillation-reaction	10	10	10	4.99	4.93	5.72	9.87	8.93	3.72	3.34
Pressure	Atmos- pheric	Atmos- pheric	Atmos- pheric	Vacuum (300 mm)	Vacuum (300 mm)	Atmos- pheric	Atmos- pheric	Atmos- pheric	2 atm	2 atm
Batch or Semi-continuous	Semi- cont.	Batch	Semi- cont.	Batch	Semi- cont.	Semi- cont.	Semi- cont.	Semi- cont.	Semi- cont.	Semi- cont.
Running onto MCB (duration)	1h 45		0 4h		0 2h	4h	4h	4h	4h	4h
Temp, starting-final	130-130°C (reflux)	20-130°C (reflux)	130-130°C (reflux)	48-100°C (reflux)	100-100°C (reflux)	130-130°C (reflux)	130-130°C (reflux)	130-130°C (reflux)	140-150°C (reflux)	130-130°C (reflux)
Duration of the rise	None	3h	None	1h	None	None	None	None	None	None
Duration of the maintenance	2h 30	3h	2h		0	0 2h	2h	2h	2h	2h
Mole, starting	1.67	1.67	1.67	1.66	1.66	1.63	1.67	1.86	1.86	1.67
Mole before distillation	1.18	1.35	1.51	1.42	1.35	1.35	1.55	1.46	1.43	1.36
CO ₂ evolution	0.05	0.05	0.05	0.09	0.09	0.08	0.06	0.7	0.11	0.1

Yd	70.66%	80.84%	90.42%	85.54%	81.33%	82.82%	92.81%	78.49%	76.88%	81.44%
Distillation Yd	99.00%	84.00%	93.00%	100.00%	85.00%	97.00%	90.00%	100.00%	104.00%	95.00%
Total Yd after distillation	70.00%	68.00%	84.00%	85.00%	76.00%	80.00%	83.00%	79.00%	80.00%	78.00%
Distribution of the light compounds in the final reaction mixture before distillation										
Carbamoyl fluoride			0.70%	3.00%	1.43%	0.47%	0.34%	2.30%	1%	4.50%
Dimer			0.90%	2.50%	1.60%	1.10%	0.98%	0.80%	1%	0.90%
Urea			1.10%	2.00%	1.00%	2.50%	1.60%	1.00%	1%	1.30%
Biuret			6.60%	12%	12.40%	10.00%	7.10%	10.50%	16%	15.10%
Isocyanate	82.93%	77.59%	90.70%	80.50%	83.57%	85.93%	89.98%	85.40%	81%	78.20%
biuret ratio			13.74242424	6.708333333	6.739516129	8.593	12.67323944	8.133333333	5.0625	5.178807947

Comment on the above results

Tests HF 07 and HF 08, although not really bad, give a relatively mediocre yield of final isocyanate. The explanation of this phenomenon is related to the low finishing temperature, which leaves a not insignificant proportion of greater than 2 or 3% of monochlorodifluoromethylphenyl.

Another reason why test HF 07 is mediocre is the speed with which the carbamoyl fluoride solution is run in, which operation lasts only 1h 45, whereas, in the other cases, it lasts significantly longer.

For tests HF 07 and HF 08, data on the impurities are lacking and consequently not very much can be concluded therefrom. For the tests for which this data is present, the isocyanate/biuret ratio can be used as an index of the selectivity of the reaction.

The reaction HF 09 gives very good results, both with regard to the overall yield and with regard to the purity of the product obtained. This demonstrates the advantage, first, of adding the carbamoyl fluoride in a form dissolved in hydrofluoric acid and, secondly, of operating with a high HF/ carbamoyl fluoride ratio. In that case, the HF/ isocyanate ratio is 10, which corresponds to the hydrofluoric acid/carbamoyl fluoride ratio of 9. The results of tests HF 10 and HF 11 under vacuum are certainly good but slightly disappointing in view of the fact of

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having operated under vacuum. However, the rate of addition or the rate of temperature rise was doubtless a little too high.

Test HF 12 is very similar to test HF 09 but
5 the difference with the latter results from the lower content of hydrofluoric acid in the mixture, more exactly the solution added.

In test HF 13, high levels of hydrofluoric acid are again found and thus a much better selectivity
10 of the reaction.

Tests HF 15 and HF 16 show the effect of the increase in the pressure, which is not very favorable.

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CLAIMS

1. A dehydrofluorination process which makes it possible to convert an aromatic carbamoyl fluoride to the corresponding isocyanate, characterized in that said carbamoyl fluoride is subjected to a temperature at least equal to 80°C, advantageously at least equal to 90°C, in a solvent and in that, at said temperature of at least 80°C, said carbamoyl fluoride is in the dissolved or finely dispersed state in the solvent.

2. The process as claimed in claim 1, characterized in that said reaction temperature is at most equal to 150°C.

3. The process as claimed in claims 1 and 2, characterized in that said solvent exhibits a boiling point of at least 100°C, advantageously 120°C.

4. The process as claimed in claims 1 to 3, characterized in that the reaction is carried out at a pressure such that, at the reaction temperature, the solvent is boiling.

5. The process as claimed in claims 1 to 4, characterized in that the solvent is chosen from those which are miscible with hydrofluoric acid, advantageously from halogenated aromatic derivatives which do not react with the carbamoyl fluoride.

6. The process as claimed in claims 1 to 5,

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characterized in that said carbamoyl fluoride is introduced into the solvent with hydrofluoric acid, advantageously in the form of a solution in anhydrous hydrofluoric acid.

5 7. The process as claimed in claim 6, characterized in that the ratio of the hydrofluoric acid to the carbamoyl fluoride (HF/carbamoyl fluoride) is at least equal to 2, advantageously to 3, preferably to 4.

10 8. The process as claimed in claims 1 to 7, characterized in that the addition of the carbamoyl fluoride, advantageously in the form of a solution, takes place gradually to a solvent heel brought to the chosen reaction temperature.

15 9. The process as claimed in claims 1 to 8, characterized in that the addition is carried out at a rate such that, in the ten final 90% of the reaction duration taking place below 100°C, advantageously below 90°C, the molar ratio of hydrofluoric acid to
20 isocyanate (HF acid/aromatic isocyanate) is always less than 0.5, advantageously than 0.3, preferably than 0.1.

 10. The process as claimed in claims 1 to 9, characterized in that the carbamoyl fluoride substrate comprises an aliphatic carbon, that is to say of sp^3
25 hybridization, carrying at least two fluorines.

 11. The process as claimed in claim 10, characterized in that said aliphatic carbon carrying at

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least two fluorines is a benzyl carbon, that is to say that it is directly attached to an aromatic ring.

12. The process as claimed in claim 11, characterized in that said aromatic ring is that
5 carrying the nitrogen of the carbamoyl functional group.

13. The process as claimed in claims 1 to 12, characterized in that the reaction mixture comprises less than 1%, with respect to the starting
10 carbamoyl fluoride, expressed as moles, of impurities exhibiting a chlorine in the benzyl position.

14. The process as claimed in claims 1 to 13, characterized in that [lacuna] substrate corresponds to the formula:

15
$$\cdot(R)_m-Ar(-(CX_2)_p-EWG)-NH-CO-F$$

where:

- Ar is an aromatic residue;
- the X units, which are alike or different, represent a fluorine or a radical of formula C_nF_{2n+1} with n an
20 integer at most equal to 5, preferably to 2;
- p represents an integer at most equal to 2;
- EWG represents a hydrocarbonaceous group or an electron-withdrawing group, the optional functional groups of which are inert under the reaction
25 conditions, advantageously fluorine or a perfluorinated residue of formula C_nF_{2n+1} with an integer at most equal to 8, advantageously to 5.

The total carbon number of $-(CX_2)_p$ -EWG is advantageously between 1 and 15, preferably between 1 and 10.

- m is 0 or an integer chosen within the closed range (that is to say, comprising the limits) 1 to 4;
- R represents alike or different radicals chosen from halogens, advantageously light halogens (that is to say, chlorine and fluorine), and hydrocarbonaceous radicals, preferably alkyl, aryl, alkylchalcogenyl (such as alkyloxy) or arylchalcogenyl (such as aryloxy) radicals.

15. The process as claimed in claims 1 to 14, characterized in that the solvents are chosen from chlorobenzenes, advantageously monochloro-, dichloro- and trichlorobenzenes.

WO 01/02347 A1

I hereby appoint the following attorneys and agent(s) to prosecute said application and to transact all business in the Patent and Trademark Office connected therewith and to file, prosecute and to transact all business in connection with international applications directed to said invention:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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**COMBINED DECLARATION AND POWER OF ATTORNEY
FOR UTILITY OR DESIGN PATENT APPLICATION**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD FOR DEHYDROGENOFUORINATION OF AN AROMATIC CARBAMOYL FLUORIDE

the specification of which (check only one item below):

- ☐ is attached hereto.
- ☐ was filed as United States application
Number _____ on _____
and was amended _____ (if applicable).
- ☒ was filed as PCT international application
Number PCT/FR00/01912 on 4 JULY 2000
and was amended _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §§119 (a)-(d), 172 or 365 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119(a)-(d), 172 or 365:				
COUNTRY (if PCT, indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. § 119, 172 or 365	
France	99/08,647	5 JULY 1999	X Yes	No
			Yes	No
			Yes	No
			Yes	No
			Yes	No

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